Nanoscale orientation control of organic semiconductor thin films on amorphous substrates by graphoepitaxy

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Graphoepitaxy, in-plain oriented crystal growth on artificial microstructures, was discovered about 40 years ago in inorganic materials [1]. We applied this technique to organic semiconductors in order to to obtain in-plain oriented films and improve the performance of organic thin film transistors (OTFTs).

By means of electron beam lithography and dry-etching, periodic grooves were fabricated on thermally oxidized silicon substrates; the pitch and depth of the grooves were 400 nm and 10 nm, respectively. The grooved substrate after UV/ozone cleaning (hydrophilic surface condition), or further treated with hexa-methyl-disiloxane (HMDS) (hydrophobic surface condition), was loaded into an ultrahigh vacuum chamber, and an α-sexithiophene (α-6T; $C_{24}H_{14}S_6$) thin film was grown on the substrate by molecular beam deposition. Atomic force microscopy (AFM) images of the substrate and grown thin films are shown in Fig. 1.

On the microgrooved surface, one-dimensional chain-like patterns of α-6T grains were observed along the grooves by AFM. Morphological analysis of crystal grains and grazing-incidence x-ray diffraction (GIXD) revealed that in-plain oriented growth (graphoepitaxy), *b*-axis ∥ grooves (*c*-axis ⊥ grooves) on hydrophilic surface and *b*-axis ⊥ grooves (*c*-axis ∥ grooves) on hydrophobic surface, was achieved [2,3]. The orientational change is caused by the interaction between α-6T and molecules terminating the groove walls, and can be used for nanoscale orientation control. Some tests confirming the effect of graphoepitaxy on the performance of OTFTs have been carried out [4]. Furthermore, we investigated the possibility of graphoepitaxy using edges of metal electrodes [5].

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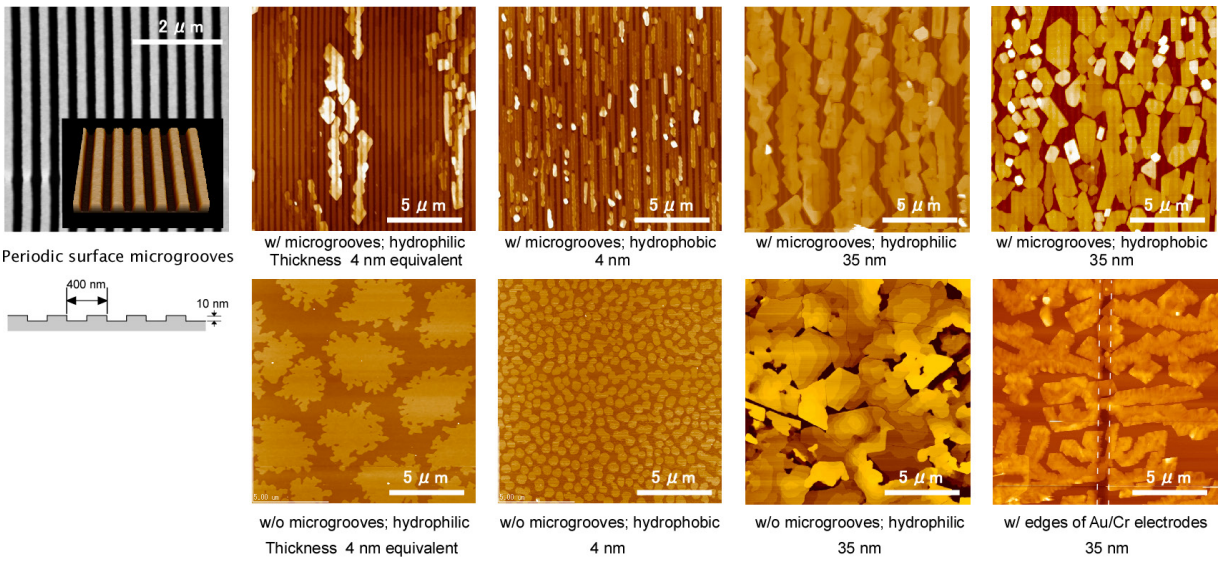

Fig. 1 AFM topographies showing morphological variation of α-6T thin films grown on substrates with/without microgrooves, with different film thickness and surface condition.

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Fields of Research

- ♦ Oriented film growth of organic semiconductors by graphoepitaxy
- ♦ Organic field effect transistors and their ambipolar characteristics
- ♦ Light emission properties of organic semiconductors and devices

(Others: Mineralogy, Petrology, Experimental petrology, Cement chemistry, Surface science)

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